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ASSIGNMENT BOOKLET
SCN3260 Physics 30
Module 5 Assignment

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Physics 30

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Wave Theory of Light

Module 5

Assignment Booklet

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FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Lesson 1 Assignment	19	
Lesson 2 Assignment	21	
Lesson 3 Assignment	31	
Lesson 4 Assignment	28	
Lesson 5 Assignment	30	
Lesson 6 Assignment	24	
	153	

Teacher's Comments

Physics 30
Module 5: Wave Theory of Light
Assignment Booklet
ISBN 978-0-7741-3205-3

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MODULE 5: LESSON 1 ASSIGNMENT

This Module 5: Lesson 2 Assignment is worth 19 marks. The value of each assignment and each question is stated in the left margin.

(19 marks) Lesson 1 Assignment: Electromagnetic Radiation

(2 marks) **A 1.** Medical technologies related to imaging and cancer treatment use high-frequency EMR. What precautions should medical personnel take when working with these types of technologies?

A 2. A student measures the period of an electromagnetic wave as 3.64×10^{-15} s.

(2 marks) a. What is the frequency of the wave?

(2 marks) b. What is the wavelength of the wave?

(1 mark) c. To which part of the electromagnetic spectrum does the wave belong?

(4 marks) **A 3.** What are the two competing models of electromagnetic radiation? Explain how each works.

(2 marks) **A 4.** Explain Young's experiment and how it proved one of the theories of electromagnetic radiation.

(1 mark) **A 5.** Where does the energy for the EMR originate?

(1 mark) **A 6.** What new concept did Maxwell introduce?

(4 marks) **D 3.** If you were to update your explanation of why light can't travel through walls based on what you learned in D 2 in the Student Module Booklet, what changes would you make? You will be marked according to the scoring criteria on the next page.

DISCUSSION SCORING GUIDE

Principles involved: wavelength, frequency, waves, and light

Criteria	Level 1 (Below Standard)	Level 2 (Approaching Standard)	Level 3 (Standard)	Level 4 (Above Standard)
Knowledge				
	Demonstrates a vague and sometimes incorrect understanding of the physics principles involved. Obvious irrelevant or missing information.	Demonstrates a basic understanding of the physics principles involved. May exhibit minor mistakes or vague information or application to the situation.	Demonstrates a good understanding of the physics principles involved and applies them properly to the given situation. All necessary information is given.	Demonstrates a superior understanding of the physics principles involved and their application to the situation. All applications are considered in detail.
Reflection				
The post shows reflection on one's own and other students' work. Contributes to the group discussion.	Does not make an effort to participate. Seems indifferent to discussion.	Occasionally makes meaningful reflections on the group's efforts or discussions. Marginal effort is shown to become involved with the group or discussion.	Frequently makes meaningful reflections on the group's efforts and presents relevant viewpoints for consideration by the group. Interacts freely with group members.	Regularly attempts to motivate the group discussion and delve deeper into concepts. Interacts freely and encourages all group members.
Content and presentation of discussion summary				
The information is logically arranged in a clear and concise manner.	The information is poorly organized with many concepts implied. Irrelevant or rambling sentences make reading difficult.	The information is somewhat organized with implied concepts. Excessive words or awkward sentences are used, which hinder reading.	The information is well-organized and logically arranged. All concepts are explicitly explained. There are a few awkward but understandable sentences.	The information is well-organized and very easy to understand. Well-worded sentences make reading pleasurable.

MODULE 5: LESSON 2 ASSIGNMENT

This Module 5: Lesson 2 Assignment is worth 21 marks. The value of each assignment and each question is stated in the left margin.

(21 marks) Lesson 2 Assignment: The Speed of Light

A 1. Do “Applications” questions 4, 7, 8, and 10 on page 652 of your textbook.

(3 marks) “Applications” question 4

(3 marks) “Applications” question 7

(3 marks) “Applications” question 8

(3 marks) “Applications” question 10

Lesson 2 Lab: Determining the Speed of Light Using a Microwave Oven

Analysis

(1 mark) **LAB 1.** Calculate the average distance of separation for at least four measurements.

(1 mark) **LAB 2.** Convert the average distance from centimetres to metres.

(1 mark) **LAB 3.** Determine the microwave wavelength.

(2 marks) **LAB 4.** Calculate the speed of light in metres per second using the microwave's frequency and wavelength according to the universal wave equation ($c = f\lambda$).

Conclusions

(1 mark) **LAB 5.** According to your observations, at what speed do microwaves travel?

____

____

(2 marks) **LAB 6.** Determine the percentage of error when your measured speed is compared to the currently accepted speed of 3.00×10^8 m/s.

$$\text{Percent Error} = \frac{\left|(\text{experimental value}) - (\text{accepted value})\right|}{(\text{accepted value})} \times 100\%$$

(1 mark) **LAB 7.** Why is the prefix “micro” used to describe “microwaves”?

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MODULE 5: LESSON 3 ASSIGNMENT

This Module 5: Lesson 3 Assignment is worth 31 marks. The value of each assignment and each question is stated in the left margin.

(31 marks) **Lesson 3 Assignment: Reflection**

Predicting the path of the reflected light, for both regular and irregular reflection is based on the law of reflection. A simulation "Light Reflection" on the Physics 30 Multimedia DVD will be used to explore the law of reflection.

- Following the instructions in the lesson, open the reflection simulation, and select ● one mirror mode.
- Click the "Show Calcs" button, Show Calcs. A box with the θ_{in} and θ_{out} values will appear.

(2 marks) **LAB 1.** The mirror angle can be adjusted using the angle slider (mirror 1 angle: 0.0). The mirror position can be adjusted by clicking and dragging the mirror on the screen.

Adjust the position and/or angle of the mirror. Record the values for θ_{in} and θ_{out} for five different rays when the mirror is at various angles or positions. Record your observations.

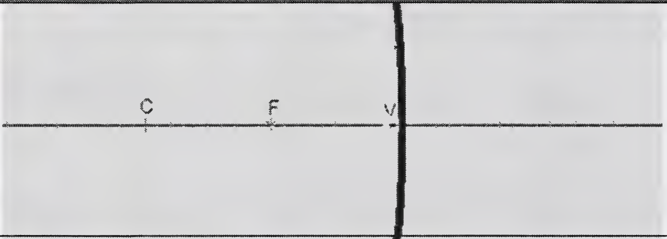
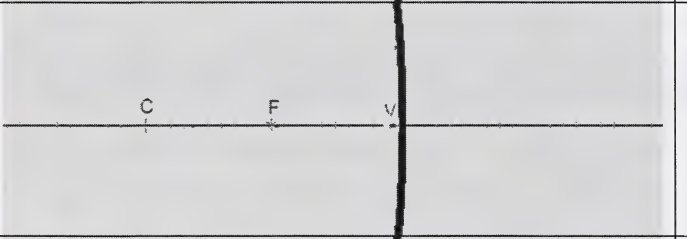
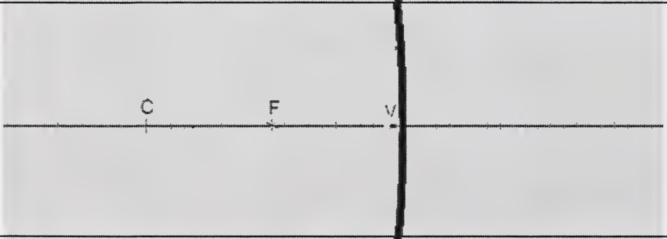
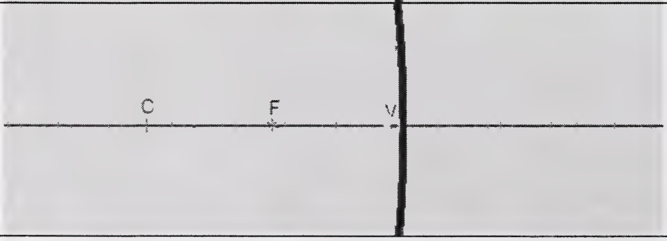
θ_{in}	θ_{out}

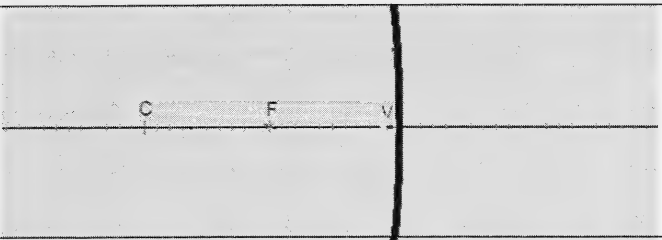
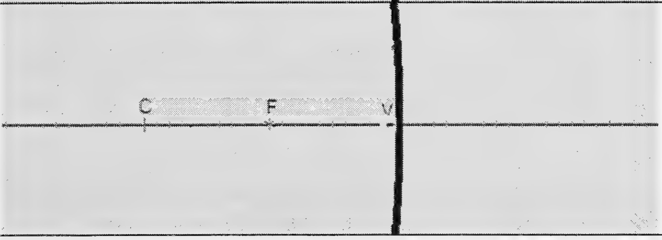
(1 mark) **LAB 2.** The law of reflection is one of the most basic of all laws in optics. It relates the angle of incidence to the angle of reflection. On the basis of the investigation that you just performed, state the law of reflection.

(6 marks) **LAB 3.** Go to the Physics 30 Multimedia DVD and open the "Thin Lens" simulation. Then select "Mirror" from the drop-down menu.

Click the object arrow, and move it to various locations on the principal axis. Using the simulation as a guide, draw diagrams and describe the image characteristics when the object is located at the positions listed in Table 1. For image characteristics, record real or virtual, attitude, magnitude, and position relative to mirror surface.

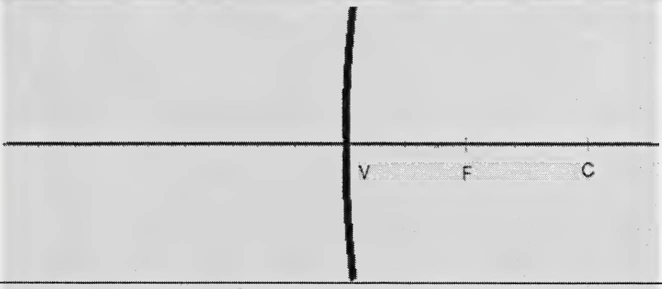
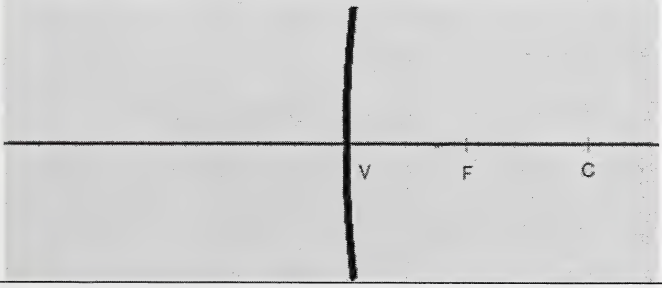
Table 1: Using Ray Diagrams to Predict Image Characteristics: Converging Mirror

Object Position	Ray Diagram	Image Characteristics
very far away (very left side)		
outside C		
at C		
between C and F		

at F		
inside F		

(2 marks) **LAB 4.** Switch the mirror in the simulation to a diverging, convex mirror by making the focal length negative (⊟). Complete Table 2. For image characteristics, record real or virtual, attitude, magnification, and position relative to mirror surface.

Table 2: Using Ray Diagrams to Predict Image Characteristics: Diverging Mirror

Object Position	Ray Diagram	Image Characteristics
very far away (very left side)		
close to the mirror		

A 1. Complete “Concept Check” questions 1 and 2 on page 662 of the textbook.

(2 marks) “Concept Check” question 1

(2 marks) “Concept Check” question 2

(3 marks) **A 2.** A converging mirror has a focal length of 20 cm. The object is placed 30 cm in front of the mirror. Where will the image appear?

(3 marks) **A 3.** A diverging mirror has a focal length of 0.12 m. The image is located 0.070 m from the mirror. Where is the object located?

(3 marks) **A 4.** A student places a 5.0-cm-tall object 15 cm away from a converging mirror. The image is 12 cm from the mirror. What is the height and orientation of the image?

(3 marks) **A 5.** A 1.5-cm-tall object is placed 12 cm away from a converging mirror. The image is magnified to four times its original height and is inverted. What is the mirror's focal length?

(4 marks) **D 1.** Work with another student to determine where, exactly, the secondary mirror should be placed so that the telescope produces a clear image of the distant object. Use a ray diagram to answer this question, and design an experiment to determine the focal length of the large, primary mirror. Your design should include the problem, prediction, materials, procedure, and analysis required to answer the problem. You will be graded according to the rubric provided on the next page.

DISCUSSION SCORING GUIDE

Principles involved: scientific method, lab procedures, reflection, and ray diagrams

Criteria	Level 1 (Below Standard)	Level 2 (Approaching Standard)	Level 3 (Standard)	Level 4 (Above Standard)
Knowledge				
Demonstrates understanding of the situation, physics principles and technology, and their connections.	Demonstrates a vague and sometimes incorrect understanding of the physics principles involved. Obvious irrelevant or missing information.	Demonstrates a basic understanding of the physics principles involved. May exhibit minor mistakes or vague information or application to the situation.	Demonstrates a good understanding of the physics principles involved and applies them properly to the given situation. All necessary information is given.	Demonstrates a superior understanding of the physics principles involved and their application to the situation. All applications are considered in detail.
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MODULE 5: LESSON 4 ASSIGNMENT

This Module 5: Lesson 4 Assignment is worth 28 marks. The value of each assignment and each question is stated in the left margin.

(28 marks) Lesson 4 Assignment: Refraction

LAB 1. Use the "Light Refraction" simulation on the Physic 30 Multimedia DVD to answer the following questions.

(1 mark) a. When light travels from a low-index medium (fast) into a high-index medium (slower), does the ray bend toward or away from the normal.

(1 mark) b. When light travels from a high-index (slower) medium into a low-index (fast) medium, does the light ray bend toward or away from the normal?

(3 marks) **LAB 2.** Return to the Physics 30 Multimedia DVD. Set up the “Light Refraction” simulation with two refractive layers. You will need to vary the refractive index for each layer and the angle of the light ray in order to complete Table 2. Select “Show Calcs” (☐ Show Calcs) to assist in recording angles. Get as close to the θi as you can, but record the actual value that you use.

Table 2: Refraction Data

n_1	θ_{in}	$n_1 \sin\theta_{in}$	n_2	θ_{out}	$n_2 \sin\theta_{out}$
1.20	45°		1.40		
1.30	32°		1.66		
1.45	45°		1.23		
1.51	40°		1.00		
1.65	45°		1.80		

According to your data in Table 2, which two values are always equal to each other?

(4 marks) **LAB 3.** Use the Water Refractions diagram and the Ethanol Refractions diagram to gather data regarding water refractions and ethanol refractions. Record your data in the tables provided.

Water Refractions

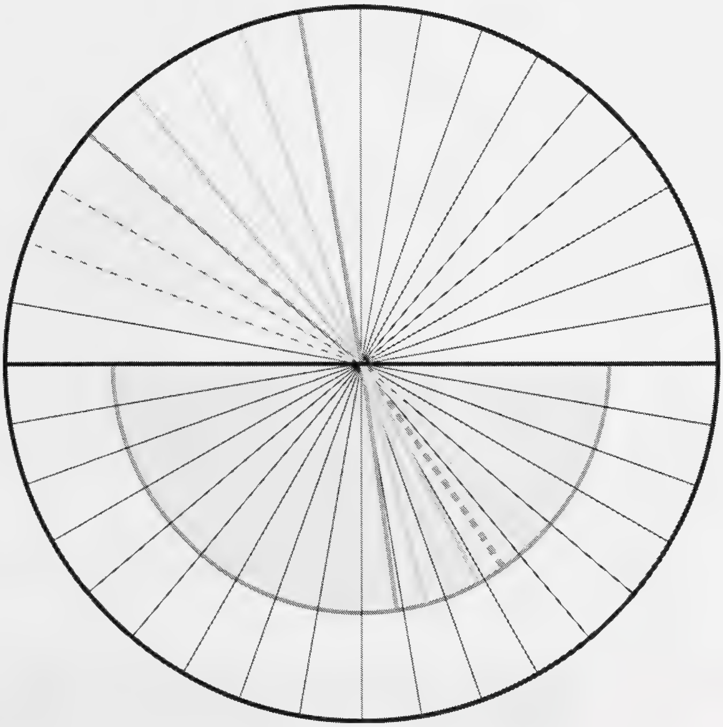


Table 1: Water Refractions

θ_1	θ_2	$\sin\theta_1$	$\sin\theta_2$	$\frac{\sin\theta_1}{\sin\theta_2}$
10				
20				
30				
40				
50				
60				
70				

Ethanol Refractions

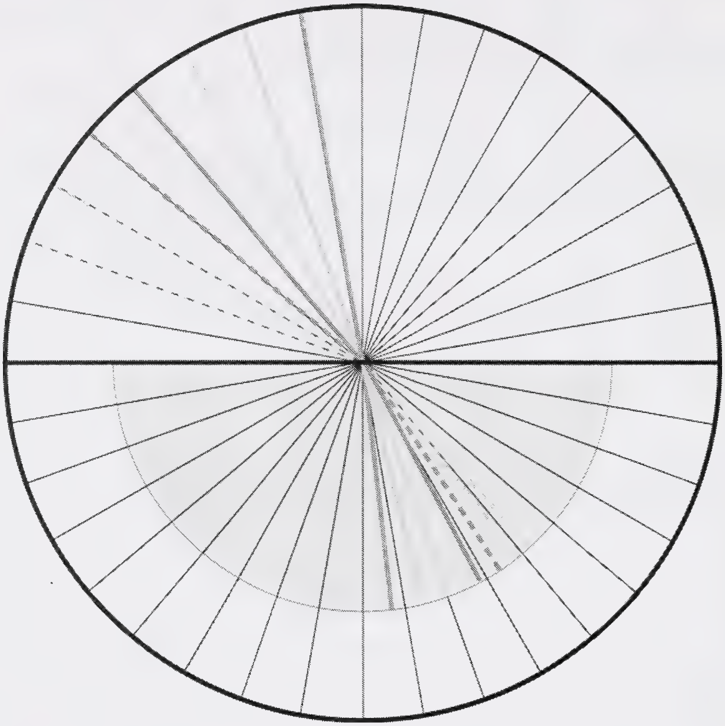


Table 2: Ethanol Refractions

θ_1	θ_2	$\sin\theta_1$	$\sin\theta_2$	$\frac{\sin\theta_1}{\sin\theta_2}$
10				
20				
30				
40				
50				
60				
70				

(4 marks) **LAB 4.** Plot a graph of sine angle of incidence versus sine angle of refraction. Plot a line for water and a line for ethanol. Calculate the slope of each line on this graph.

LAB 5. Complete "Analysis" questions 3–8 on page 671 of your textbook.

(1 mark) "Analysis" question 3

(1 mark) “Analysis” question 4

(1 mark) “Analysis” question 5

(1 mark) “Analysis” question 6

(1 mark) “Analysis” question 7

(1 mark) “Analysis” question 8

LAB 6. Using the “Light Refraction” simulation on the Physics 30 Multimedia DVD, set the refractive index of the top layer to equal 1.00 and the refractive index of the bottom layer to equal 1.33. Position the laser pointer in the bottom layer near the left side and project it upward.

(2 marks)

a. Complete Table 3 by rotating the laser pointer to the angles specified and calculating the angle of refraction using Snell's Law. (It has been manipulated to solve for the angle of refraction.) Note: Refraction will not occur for all the angles in the table.

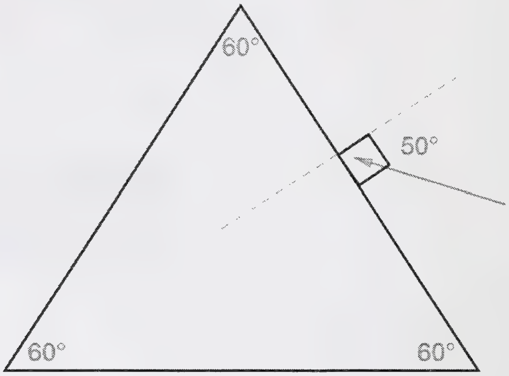
Table 3: Total Internal Reflection Data

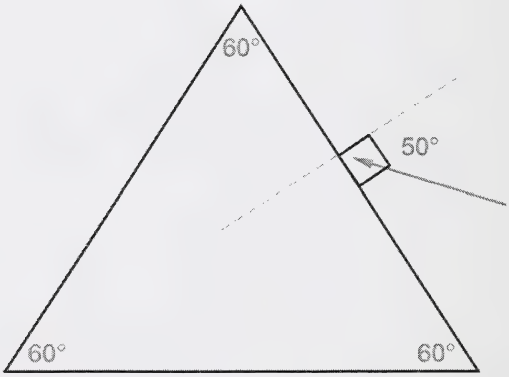
θ_1	$\theta_2 = \sin^{-1}\dfrac{\sin\theta_1(1.33)}{(1.00)}$	θ_2
35°		
40°		
45°		
50°		
55°		

(2 marks)

b. What is the maximum possible angle of incidence that still causes refraction? Describe what happens to the ray of light if the angle of incidence exceeds this value.

(5 marks) **LAB 7.** Consider white light entering an equilateral prism at a 50° angle with respect to the normal of one of its faces. If the index of refraction is 1.66 for blue light and 1.62 for red light, how far apart, in degrees, will the two rays emerge? Trace the path of the blue and red light on each prism. Sketch and label all angles and determine the angular separation between the blue and red rays as they leave the prism. Use the Prism simulation to verify your answer.





MODULE 5: LESSON 5 ASSIGNMENT

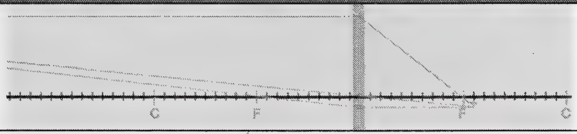
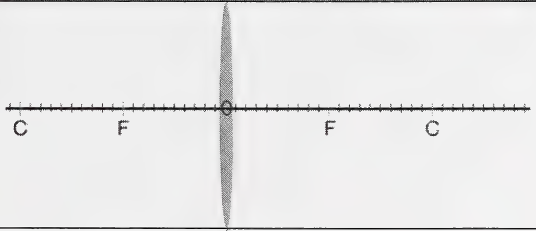
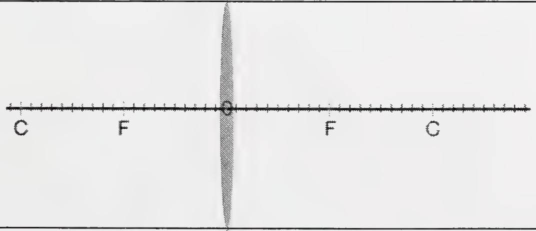
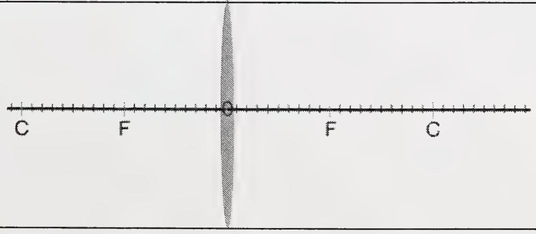
This Module 5: Lesson 5 Assignment is worth 30 marks. The value of each assignment and each question is stated in the left margin.

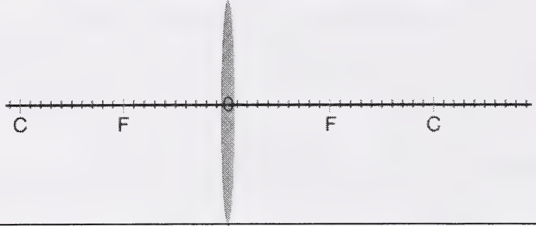
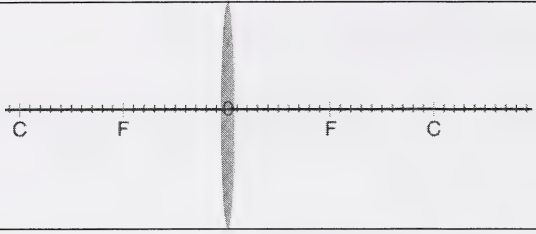
(30 marks) Lesson 5 Assignment: Refraction, Lenses, and Optical Systems

(5 marks) **LAB 1.** Go to the Physics 30 Multimedia DVD and open the "Thin Lens" simulation. Then select "Lens" from the drop-down menu (if needed).

Click the object arrow and move it to various locations on the principal axis. Using the simulation as a guide, draw ray diagrams and describe the image characteristics when the object is located at the positions listed in Table 1. The first one is done as an example.

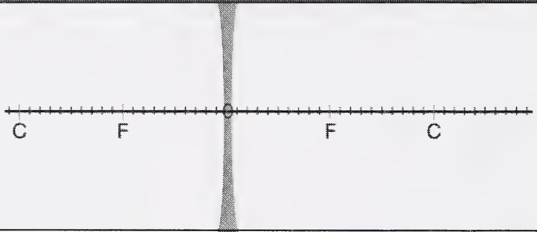
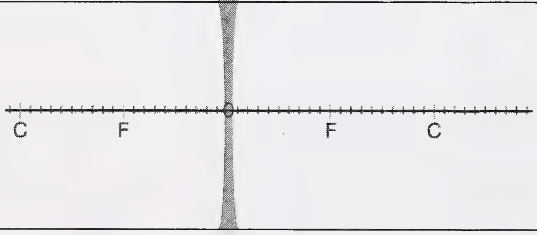
Table 1: Using Ray Diagrams to Predict Image Characteristics—Converging Lens

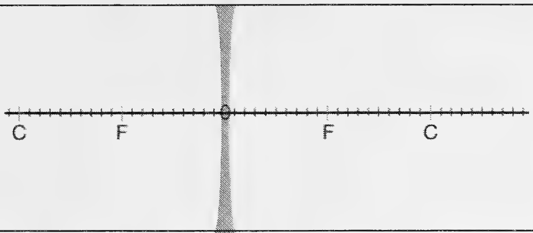
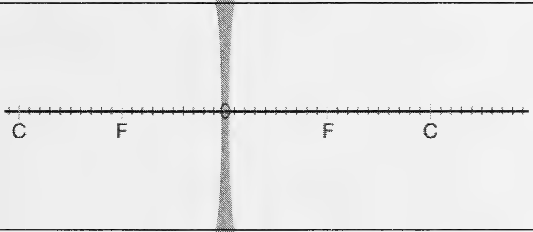
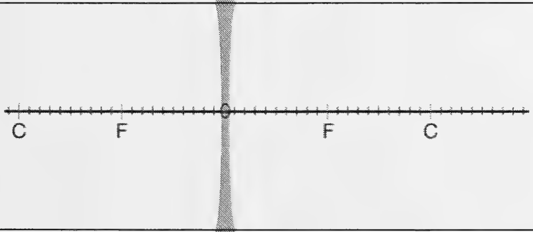
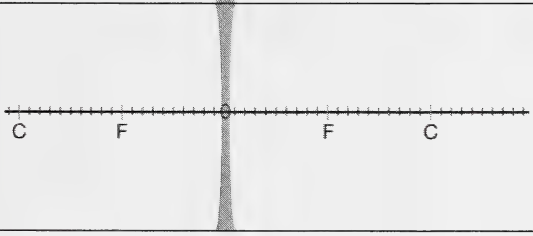
Object Position	Ray Diagram	Image Characteristics (real or virtual, attitude, magnification, position relative to lens)
very far away		The image is real, inverted, much smaller than the object, and is located at F.
outside C		
at C		
between C and F		

at F		
inside F		

(5 marks) **LAB 2.** Switch the lens in the simulation to a diverging lens by making the focal length negative (-). Complete Table 2.

Table 2: Using Ray Diagrams to Predict Image Characteristics—Diverging Lens

Object Position	Ray Diagram	Image Characteristics (real or virtual, attitude, magnification, position relative to lens)
very far away		
outside C		

at C		
between C and F		
at F		
inside F		

A 1. A converging lens with a focal length of 5.0 cm is placed 12 cm away from an 8.0-cm-tall object.

(3 marks) a. How far from the lens is the image?

(2 marks) b. How tall is the image?

(1 mark) c. Describe the image characteristics: real/virtual, inverted/erect, enlarged/smaller.

____

A 2. A scientist uses a converging lens, with a 17 cm focal length, to focus light to create a holograph. The lens is 30 cm from the 25-cm-tall image.

(3 marks) a. How far from the lens is the object?

(2 marks) b. What is the height of the object?

(1 mark) c. Describe the image characteristics: real/virtual, inverted/erect, enlarged/smaller.

____

A 3. A student is given the challenge of determining the focal length of the lens in an LCD projector. The projector creates an image 600 cm tall, 12 m from the lens. The object is 12 cm tall.

(2 marks) a. What is the distance to the object?

(2 marks) b. What is the focal length of the lens?

(4 marks) **D 3.** Now that you have seen other students' rules from question D 2 in the Student Module Booklet, reflect on your rules and improve them. What are your new rules, and how did reading the other students' rules help you to improve your own understanding? You will be graded according to the scoring rubric provided on the next page.

DISCUSSION SCORING GUIDE

Principles involved: refraction, lens, and ray diagrams				
Criteria	**Level 1 (Below Standard)**	**Level 2 (Approaching Standard)**	**Level 3 (Standard)**	**Level 4 (Above Standard)**
		Knowledge		
	Demonstrates a vague and sometimes incorrect understanding of the physics principles involved. Obvious irrelevant or missing information.	Demonstrates a basic understanding of the physics principles involved. May exhibit minor mistakes or vague information or application to the situation.	Demonstrates a good understanding of the physics principles involved and applies them properly to the given situation. All necessary information is given.	Demonstrates a superior understanding of the physics principles involved and their application to the situation. All applications are considered in detail.
		Reflection		
The post shows reflection on one's own and other students' work. Contributes to the group discussion.	Does not make an effort to participate. Seems indifferent to discussion.	Occasionally makes meaningful reflections on the group's efforts or discussions. Marginal effort is shown to become involved with the group or discussion.	Frequently makes meaningful reflections on the group's efforts and presents relevant viewpoints for consideration by the group. Interacts freely with group members.	Regularly attempts to motivate the group discussion and delve deeper into concepts. Interacts freely and encourages all group members.
		Content and presentation of discussion summary		
The information is logically arranged in a clear and concise manner.	The information is poorly organized with many concepts implied. Irrelevant or rambling sentences make reading difficult.	The information is somewhat organized with implied concepts. Excessive words or awkward sentences are used, which hinder reading.	The information is well-organized and logically arranged. All concepts are explicitly explained. There are a few awkward but understandable sentences.	The information is well-organized and very easy to understand. Well-worded sentences make reading pleasurable.

MODULE 5: LESSON 6 ASSIGNMENT

This Module 5: Lesson 6 Assignment is worth 24 marks. The value of each assignment and each question is stated in the left margin.

(24 marks) Lesson 6 Assignment: Diffraction and Interference

A 1. After viewing the video clip, draw two waves (one below the other) and the resultant wave to illustrate the following.

(2 marks) a. complete constructive interference

(2 marks) b. complete destructive interference

A 2. Using the "Diffraction Grating" simulation on the Physics 30 Multimedia DVD, set the slit count to 2.0, the wavelength to 550.0 nm, the slit width to 0.1 mm, and the slit spacing to 0.2 mm. Observe how the following changes affect the interference pattern.

(1 mark) a. decreasing the wavelength

____

(1 mark) b. increasing the wavelength

____

(1 mark) c. decreasing the slit width

(1 mark) d. increasing the slit width

(1 mark) e. decreasing the slit spacing

(1 mark) f. increasing the slit spacing

(3 marks) **A 3.** A scientist is double-checking the wavelength of a new laser. The scientist sets up a diffraction grating with 5.00×10^{-6} m between slits, in front of the laser 1.50 m in front of a screen. The scientist measures the distance from the central maximum to the second bright fringe, which is 0.330 m. What is the wavelength of the laser?

A 4. As part of a laser light show, the technician is adjusting a diffraction grating. A green laser with a wavelength of 532 nm is shone on a diffraction grating with 2700 lines/cm. The screen is 35 m from the diffraction grating.

(1 mark) a. What is the distance between the slits of the diffraction grating?

(3 marks) b. How far from the central maximum will the bright fringe be?

(3 marks) **A 5.** A student is looking at a monochromatic light source and is looking for the third bright fringe. The light has a wavelength of 625 nm and has passed through a diffraction grating with a slit separation of 2.80×10^{-6} m. At what angle should the student look for the third bright fringe?

(4 marks) **D 3.** Improve your answer to D 1 in the Student Module Booklet, and state what improvements you made to your solution and why. You will be graded according to the rubric provided on the next page.

DISCUSSION SCORING GUIDE

Principles involved: polarized light and filters				
Criteria	**Level 1 (Below Standard)**	**Level 2 (Approaching Standard)**	**Level 3 (Standard)**	**Level 4 (Above Standard)**
Knowledge				
	Demonstrates a vague and sometimes incorrect understanding of the physics principles involved. Obvious irrelevant or missing information.	Demonstrates a basic understanding of the physics principles involved. May exhibit minor mistakes or vague information or application to the situation.	Demonstrates a good understanding of the physics principles involved and applies them properly to the given situation. All necessary information is given.	Demonstrates a superior understanding of the physics principles involved and their application to the situation. All applications are considered in detail.
Reflection				
The post shows reflection on one's own and other students' work. Contributes to the group discussion.	Does not make an effort to participate. Seems indifferent to discussion.	Occasionally makes meaningful reflections on the group's efforts or discussions. Marginal effort is shown to become involved with the group or discussion.	Frequently makes meaningful reflections on the group's efforts and presents relevant viewpoints for consideration by the group. Interacts freely with group members.	Regularly attempts to motivate the group discussion and delve deeper into concepts. Interacts freely and encourages all group members.
Content and presentation of discussion summary				
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